STORMWATER TREATMENT AREA NO. 3 & 4

PLAN FORMULATION

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10. HOLEY LAND IMPACTS

10.1 INTRODUCTION

The Holey Land Wildlife Management Area consists of a total area of approximately 35,000 acres generally bounded by the Miami Canal on the west and the L-5 levees and borrow canal on the south. The Holey Land extends seven miles north of the L-5 system, and an average of roughly seven miles east of the Miami Canal. The total area of the Holey Land includes approximately 3,680 acres in the "Toe of the Boot", an addition to the original area of the Holey Land located along and immediately north of the L-5 system at the southeasterly corner of the original Holey Land.

The Holey Land is operated by the South Florida Water Management District (SFWMD) pursuant to the "Holey Land and Rotenberger Project Memorandum of Agreement" (MOA) between SFWMD and the Florida Game and Fresh Water Fish Commission (FGFFC).

In addition, a Memorandum of Agreement between the Florida Department of Environmental Protection (FDEP), the Board of Trustees of the Internal Improvement Trust Fund, the Florida Fish and Wildlife Conservation Commission (FFWCC, successor to the FGFCC) and the SFWMD established an environmental restoration plan for the Holey Land. As part of the restoration plan, water quality monitoring was implemented to meet the requirements of FDEP Permit No. 06-500809209.

This Section 10 evaluates the potential impacts of the STA-3/4 and East WCA-3A Hydropattern Restoration Works on the Holey Land, and presents recommendations for specific actions considered necessary and desirable to mitigate those potential impacts.

Potential impacts considered in this evaluation include:

- **Seepage** - Incremental inflows to the Holey Land (additional seepage inflows) occasioned by the development of elevated water stages along the northerly and easterly perimeters of the Holey Land as a result of the project. Those incremental inflows are evaluated with respect to the ability of SFWMD to operate the Holey Land in accordance with established operating schedule(s).
- **Discharge** - The potential influence of construction and operation of the recommended Outflow and Distribution Works (part of the East WCA-3A Hydropattern Restoration component of the overall project) on SFWMD's capacity to discharge from the Holey Land using existing water control structures G-204, G-205 and G-206.
- **Phosphorus loads** - The potential influence of construction and operation of the project (including other components of the Everglades Construction Project) on total phosphorus loads introduced to the Holey Land at existing pumping station G-200A, the single existing point of inflow to the Holey Land.
- **Recreational access** - Potential impacts of project construction and operation on recreational access to the Holey Land Wildlife Management Area.

An overall map of the Holey Land, identifying existing water control structures and the general relationship of the Holey Land to physical works included in the STA-3/4 and East WCA-3A Hydropattern Restoration Project, is presented in Figure 10.1.

Here insert Figure 10.1

10.2 EXISTING CONDITIONS

This section:

- Presents a description of the physical works forming the Holey Land Wildlife Management Area,
- Defines the Holey Land regulation schedule considered in this evaluation,
- Summarizes historic inflow volumes and total phosphorus loads to the Holey Land,
- Presents a summary of historic data on Holey Land interior stages and discharges, and
- Defines existing means of recreational access.

10.2.1 Description of Physical Works

Physical works forming the Holey Land consist of a mix of facilities originally constructed as elements of the federal Central and Southern Florida (C&SF) Project for Flood Control and Other Purposes and facilities constructed by the SFWMD specifically to support the Holey Land's development and operation.

The Holey Land's westerly perimeter levee is formed by the easterly Levee L-24, a part of the C&SF Project constructed along and adjacent to the Miami Canal. The top elevation of East L-24 is variable, but generally ranges from 19 to 23 feet NGVD. The Holey Land's southerly perimeter is formed by the North Levee L-5, also a part of the C&SF Project. Within the limits of the Holey Land, the top elevation of the North L-5 levee is approximately elevation 19 feet NGVD.

The northerly and easterly perimeter levees for the Holey Land were constructed by the SFWMD; the design top elevation of the levee throughout that reach is 19.0 feet NGVD. Those levee embankments were obtained from materials excavated from a seepage collection canal constructed along that entire perimeter, situated along and immediately

exterior to the perimeter levee, as well as from an internal distribution canal. The internal distribution canal was constructed along and immediately interior to the perimeter levee.

Existing Holey Land discharge structures consist of three culvert structures (G-204, G-205, and G-206) located along the south perimeter (at north levee L-5) of the Holey Land. A summary of record descriptive data for those structures, taken from the October 1991 (revised December 1991) *Application for Interim Permit for District Structures Discharging Into and Within the Everglades Protection Area*, SFWMD, is presented in Table 10.1.

Table 10.1

Record Data for Structures G-204, G-205 and G-206

Structure No.	Description	Culvert Barrels			
		No.	Dia. (in.)	Length (ft.)	Inv. El. (ft NGVD)
G-204	Culvert with Riser and Stoplogs	4	72	72	5.39
G-205	Culvert with Riser and Stoplogs	6	72	72	4.44
G-206	Culvert with Riser and Stoplogs	5	66	66	3.75

Detailed surveys of G-204, G-205 and G-206 were conducted in June and July 1999 by Adair & Brady, Inc. of West Palm Beach under subcontract to Burns & McDonnell. A summary of data for those structures resulting from that survey is presented in Table 10.2. The data resulting from the recent surveys does vary in certain detail from previously reported information, but the differences are not considered significant. Plan views resulting from those surveys are included in Figures 10.2, 10.3 and 10.4.

Here insert Figure 10.2

Here insert Figure 10.3

Here insert Figure 10.4

Table 10.2

Surveyed Data for Structures G-204, G-205 and G-206

Description	Units	Structure Identification		
		G-204	G-205	G-206
Culvert Barrels				
Number	No.	4	6	5
Length	Feet	72	72	72
Barrel Diameter	Inches	72	72	66
Upstream Invert Elevations				
Minimum	Ft. NGVD	4.94	4.47	3.55
Maximum	Ft. NGVD	5.31	4.82	4.05
Average	Ft. NGVD	5.09	4.64	3.85
Downstream Invert Elevations				
Minimum	Ft. NGVD	5.08	4.01	4.67
Maximum	Ft. NGVD	5.25	4.29	4.90
Average	Ft. NGVD	5.18	4.14	4.73
Approx. South Bank "Gap" Elev.	Ft. NGVD	13.1	11.6	11.6
Measured Water Surface Elevation				
Date of Measurement	---	07/13/99	07/30/99	06/22/99
Headwater (Holey Land)	Ft. NGVD	10.80	12.05	11.64
Tailwater (L-5 Canal)	Ft. NGVD	10.80	12.01	11.36

As originally constructed under the C&SF Project, each of the structures directly discharged to the L-5 Borrow Canal, which was open and free-flowing between the Miami Canal and the North New River Canal. Subsequent to the original construction of these structures, earth plugs were constructed across the L-5 Borrow Canal. Interconnectivity between the pools formed by those plugs is maintained by 24-inch diameter corrugated metal culverts constructed across the plugs along the line of the L-5 Borrow Canal. The earth plugs extend between the North Levee L-5 and the South Levee L-5. The South Levee L-5 was degraded directly south of the culverts and between the earth plugs, establishing a direct connection between the culverts and WCA-3A. A generalized schematic of the Holey Land discharge system as it now exists is presented in Figure 10.5.

Here insert Figure 10.5

Inflows to the Holey Land are introduced from Pumping Station G-200A, situated at the northwesterly corner of the Holey Land. G-200A draws from the Miami Canal and discharges to the distribution canal in the interior of the Holey Land. It is equipped with three axial flow pumps, each providing a nominal capacity of 200 cfs; the total installed capacity of G-200A is 600 cfs. Two additional pumping stations, G-200B and G-201, located at the northwesterly and southeasterly corners of the Holey Land, respectively. These seepage return pumping stations draw from the seepage collection canal along the perimeter of the Holey Land and discharge recovered seepage back to the interior of the Holey Land. Each of these two pumping stations is equipped with three hydraulic pumps, providing a total installed capacity at each station of 165 cfs.

10.2.2 Holey Land Regulation Schedule

The original regulation schedule for the Holey Land was established in a June 28, 1990 Agreement between SFWMD and FGFFC. That schedule, defined in the Agreement as an interim operational plan, directed that runoff from the Miami Canal basin be utilized to maintain stages in the Holey Land, subject to the availability of water. The schedule varied linearly with time between elevation 13.5 ft. NGVD on November 1 of any year to 11.5 ft. NGVD on May 15 of any year. That schedule was developed based on an estimated average ground surface elevation in the Holey Land of 11.5 ft. NGVD. For operational decisions, the average stage in the Holey Land was defined as the water level in the interior pond at SFWMD's stage data collection station G-203, located on the easterly boundary of the Holey Land four miles south of the north perimeter. The FGFFC subsequently proposed a modified "test" operational schedule, in which stages in the Holey Land are reduced markedly from the original schedule. That "test" schedule is presented in Figure 10.6. For the purposes of this evaluation, the estimated transfers of flow (by seepage) between STA-3/4, the Holey Land and the G-372 Supply Canal was based upon an assumption of uniform adherence to the lower range of the "Blue Zone". That schedule varies from elevation 12.0 on November 1 to 10.75 on April 15, to elevation 10.75 on June 15.

Here insert Figure 10.6

10.2.3 Historic Inflow Volumes and Total Phosphorus Loads at G-200A

Estimated inflow volumes and TP loads at G-200A over the 8-year period January 1, 1991 through December 31, 1998 are taken from an Excel file (EAABAL.xls) prepared for SFWMD by W.W. Walker, Ph.D., dated June 30, 1998. Over that period, inflow volumes to the Holey Land at G-200A averaged 71,400 acre-feet per year, ranging from a minimum of 300 acre-feet in 1995 to slightly over 140,000 acre-feet in 1992.

Over that same period, annual TP loads discharged to the Holey Land at G-200A averaged 11.8 metric tonnes, varying from a minimum of 0.3 metric tons (1995) to a maximum of 26.8 metric tons (1992). The flow-weighted mean inflow TP concentration over those 8 years was 132 ppb.

Review of the available information from the EAABAL file indicates two distinct operating periods, generally separated by calendar year 1995. That year was an extremely "wet" year, during which virtually no inflows were introduced to the Holey Land at G-200A. The period subsequent to 1995 is considered representative of the current operation of the Holey Land. The period before 1995 is considered representative of Holey Land operations under the original regulation schedule.

For the 4-year period 1991-1994, G-200A discharges averaged 98,200 acre-feet per year, at a flow-weighted mean TP concentration of 148 ppb. For the 3-year period 1996-1998, G-200A discharges averaged 55,100 acre-feet per year, at a flow-weighted mean TP concentration of 82 ppb.

Information on G-200A discharges during calendar year 1999 is taken from the District's website, which reports a discharge volume of approximately 50,000 acre-feet and a discharged TP load of approximately 3.3 metric tons (approx. flow-weighted mean TP concentration of 53 ppb).

10.2.4 Historic Operation of Seepage Return Pumping Stations

Historic data on the volume of recovered seepage returned to the Holey Land at seepage return pumping stations G-200B and G-201 were taken from the District's data files. The data were retrieved for the period including calendar years 1992 (first full year of data) through 1999 (last full year of data). Information at G-200B was taken from DBKEY 15155; information at G-201 was taken from DBKEY 15156. The historic pumpage volume at these two stations is summarized in Table 10.3.

Table 10.3

Historic Seepage Return at G-200B and G-201

Calendar Year	Seepage Return at Pump Sta. G-200B (ac-ft)	Seepage Return at Pump Sta. G-201 (ac-ft)	Total Seepage Return (ac-ft)
1992	10,893	42,846	53,739
1993	9,460	67,272	76,732
1994	8,724	72,672	81,396
1995	9,427	68,694	78,120
1996	4,563	55,537	60,100
1997	4,978	45,993	50,972
1998	8,088	56,989	65,077
1999	8,543	55,348	63,891
Ave. Annual	**8,084**	**58,169**	**66,253**

The District reports in its website that total phosphorus concentrations at G-200B and G-201 average 14 ppb and 10 ppb, respectively.

10.2.5 Historic Discharges at G-204, G-205 and G-206

Historic data on the volume of water discharged from (and introduced to) the Holey Land at structures G-204, G-205 and G-206 were taken from the District's data files. The data were retrieved for the period including calendar years 1992 (first full year of data) through 1999 (last full year of data). Information at G-204 was taken from DBKEY 15051; information at G-205 was taken from DBKEY 15054; information at G-206 was taken from DBKEY 15057. Those historic volumes are summarized in Table 10.4.

Table 10.4

Historic Inflows and Outflows at G-204, G-205 and G-206
(All volumes are in acre-feet)

Year	G-204		G-205		G-206		Total	
	Outflow	**Inflow**	**Outflow**	**Inflow**	**Outflow**	**Inflow**	**Outflow**	**Inflow**
1992	120	16,363	3,435	5,573	50,041	0	53,596	21,936
1993	0	40,588	17,263	0	35,559	0	52,822	40,588
1994	0	65	1	46	2	0	2	111
1995	0	465	0	77	0	0	0	542
1996	0	6	0	0	0	0	0	6
1997	0	0	0	0	0	0	0	0
1998	0	45	0	0	0	0	0	45
1999	51	160	3	0	0	0	54	160
Ave.	**21**	**7,211**	**2,588**	**712**	**10,700**	**0**	**13,309**	**7,923**

Inspection of the data summarized in Table 10.4 clearly indicates a change in the operation of the outflow control structures, with the change apparently occurring in 1994-1995. That observation is consistent with the environmental restoration plan adopted by the various agencies party to the Memorandum of Agreement, which requires that the outflow control structures be closed.

The District reports on its website that a total phosphorus gradient is evident at these three outflow stations, with TP concentrations at G-204 and G-205 generally higher than those at G-206. Historically, TP concentrations at G-204 and G-205 are reported to have averaged approximately 50 ppb, compared with 26 ppb at G-206.

10.2.6 Existing Recreational Access

Existing public access to the Holey Land is from two directions. The primary means of access is from U.S. Highway 27 along the North Levee L-5 to the vicinity of existing pumping station G-201. That access route also provides a means of access to WCA-3A, with crossings of the L-5 Borrow Canal at each of the earthen plugs east and west of the three outflow culverts discussed earlier in this Section 10. A secondary route to the Holey Land from the north exists along the easterly levee paralleling the Miami Canal.

10.3 IDENTIFICATION OF POTENTIAL IMPACTS

As indicated in Figure 10.1, construction proposed in connection with STA-3/4 and the East WCA-3A Hydropattern Restoration will impact the north, east, and south perimeters of the Holey Land. In addition, operational changes at existing pumping station S-8 resulting both from this project and the implementation of other components of the Everglades Construction Project could impact the westerly perimeter of the Holey Land.

The north perimeter of the Holey Land (as well as the northerly 2.6 miles of its easterly perimeter) will be directly abutted by the proposed Supply Canal from new pumping station G-372. Stages throughout that length of the perimeter will be elevated above existing ground surface elevations, and will commonly lie above the new regulation schedule in the Holey Land. This can be expected to result in additional induced seepage to the Holey Land, and a reduction in historic seepage losses from the Holey Land. In addition, construction of the new Supply Canal will include filling of the existing seepage collection canal.

Cell 3 of STA-3/4 will also directly abut an additional 2.4 miles of the Holey Land's easterly perimeter. Stages throughout that length of the perimeter will be elevated above existing ground surface elevations, and will commonly lie above the new regulation schedule in the Holey Land. This can also be expected to result in additional induced seepage to the Holey Land, and a reduction in historic seepage losses from the Holey Land. In addition, the existing seepage collection canal along this reach will be filled in order to prevent the potential for short-circuiting in Cell 3.

The Cell 3 discharge canal will directly abut the entire north line of the Toe of the Boot, as well as the majority of the east perimeter of the Toe of the Boot. Stages in the Cell 3 discharge canal will generally fall within the same range as the new regulation schedule in the Holey Land. However, the results of the seepage analysis (Section 4) do indicate that deep seepage can pass between the Holey Land and the interior of Cells 3 and 2B (e.g., beneath the discharge canal). Throughout this reach, the Cell 3 discharge canal will

be constructed as an enlargement of the existing seepage collection canal along the north boundary of the Toe of the Boot.

The south perimeter of the Holey Land abuts the L-5 levee and canal system. The L-5 Borrow Canal will be enlarged throughout this reach in order to increase conveyance for the delivery of STA-3/4 to pumping stations S-8 and G-404. The enlargement will be constructed entirely along the south bank of the L-5 Borrow Canal, with the result that no physical modification (other than removal of the "plugs" each side of the Holey Land outflow structures, see Figure 10.5) will be made to existing Holey Land facilities. It is also anticipated that operation of the project will result in a modification (lowering) of the historic canal stage-durations in the L-5 Borrow Canal (subsequently discussed in 10.4). The net impact of this change will be to increase the quantity of seepage from the Holey Land to the L-5 Borrow Canal.

Operational modifications at Pumping Station S-8 necessary for the proper operation of STA-3/4 will also modify historic stage-durations in the Miami Canal along the westerly perimeter of the Holey Land. As discussed in Section 8 of this *Plan Formulation* document, S-8 headwater elevations during operation of the project are expected to vary between elevations 10.0 and 10.7 ft. NGVD; the historic headwater elevation at S-8 averaged approximately elevation 11.5 ft. NGVD, but varied up to 13.8 ft. NGVD. The net impact of this change will be to increase the quantity of seepage from the Holey Land to the Miami Canal, and to reduce the quantity of seepage from the Miami Canal to the Holey Land.

Potential impacts discussed to this point have focused primarily on water quantity; water quality in discharges to the Holey Land will also be affected by the construction of STA-3/4 and other works of the Everglades Construction Project (STA-5). The Holey Land inflow pumping station G-200A draws from the Miami Canal; the point of withdrawal is immediately downstream of proposed Structure G-373 (gated diversion structure in the Miami Canal). Historically, the majority of inflows to the Holey Land at G-200A consisted of untreated runoff from the S-8/S-3 basin of the Everglades Agricultural Area.

Following completion of STA-3/4 and the STA-5 Outlet Canal (see Figure 10.1 for its location), inflows to the Holey Land at G-200A will consist of treated discharges from STA-5 and STA-3/4, with the result that the quality of the inflows are expected to improve.

An additional potential impact on the Holey Land is the possibility of interruptions in access due to construction and operation of the project. The primary route of public access to the Holey Land is along north levee L-5. The design and proposed sequence for construction of STA-3/4 has been developed to maintain continuous access to the Holey Land along that route, with the result that **access to the Holey Land along L-5 will not be interrupted by construction or operation of STA-3/4**.

A secondary access to the Holey Land presently exists along the east levee of the Miami Canal. No public right-of-way presently exists along that route; it is used by the public on an "opportunity" basis with no established rights for access. That secondary access will be severed by construction of the G-372 inflow and supply canals. While it would be physically possible to maintain public access through use of the service bridge along the west face of pumping station G-372, such use is not recommended. Accordingly, **it is recommended that public access to the Holey Land along the east Miami Canal levee be eliminated in connection with the construction of STA-3/4**. It should be practicable to provide access across the G-372 service bridge for FGFFC personnel.

10.4 QUANTIFICATION OF POTENTIAL IMPACTS

Potential hydrologic and water quality impacts are quantified based on the results of analyses summarized and presented in Sections 4 (Seepage Investigations and Analysis), 7 (Operational Simulations), 8 (Canal and Structure Hydraulics) and 9 (Projected Treatment Performance) of this *Plan Formulation Document*. Potential impacts on access to the Holey Land are identified in 10.3 and not further discussed in this section.

10.4.1 Existing Holey Land WMA Water Balance and Inflow TP Loads

Given the information presented earlier in this Section 10, as well as data taken from other sections of this Plan Formulation document, an estimated average annual water balance and average annual inflow TP load for the Holey Land has been developed. This information is approximate in nature, but is considered generally representative of existing conditions given operation of the Holey Land under the "test" regulation schedule. Table 10.5 summarizes that information.

Table 10.5

Holey Land WMA

Estimated Average Annual Water Balance and Inflow TP Loads

Description	**Inflow**			**Outflow (ac-ft)**
	Volume (ac-ft)	**TP Conc. (ppb)**	**TP Load (tonnes)**	
G-200A	54,000	75	5.0	0
G-200B	6,500	14	0.1	6,500*
G-201	53,500	10	0.7	53,500*
G-204	0	--	0	0
G-205	0	--	0	0
G-206	0	--	0	0
Rainfall/ET	148,000	30	5.5	166,000
Net Seepage	0	--	0	36,000
Total	**262,000**	**35**	**11.3**	**262,000**

*Recovered Seepage

In the above tabulation,

- Inflows and outflows at the various structures are assigned at the mean values for the period 1996-1999, using the information discussed earlier in this Section 10.
- Rainfall and evapotranspiration losses are assigned at average annual values reported in Section 9 of this *Plan Formulation* for STA-3/4 over the period 1965-1995 (1.29 m/yr and 1.45 m/yr, respectively). Those average annual depths are applied to the 35,000-acre area of the Holey Land.
- Atmospheric deposition of total phosphorus is assigned at the mean concentration (if attached to rainfall) employed in Section 9 for analysis of STA-3/4.

- Net (unrecovered) seepage loss is assigned at the value necessary to result in an overall water balance given the other inflows and outflows discussed above.

10.4.2 Estimated Average Annual Impacts due to Project

As discussed in Section 7 of this *Plan Formulation*, construction and operation of STA-3/4 is estimated to result in an additional average annual inflow (due to induced seepage) to the Holey Land of between 14,654 acre-feet per year (Scenario 1, where all recoverable seepage waters are discharged) and 19,624 acre-feet per year (Scenario 2, where all recoverable seepage waters are returned). Those values were computed assuming the Holey Land would have been operated in strict accord with the "test" regulation schedule throughout the period 1965-1995. Those values do not consider the potential increase in seepage losses to the L-5 and Miami canals due to lowering of stage durations in those water bodies, as insufficient information is available on which to base an analysis. As a result, the net impacts discussed herein may be considered as conservatively stated.

In order to assure a degree of conservatism in this analysis, the average annual induced seepage to the Holey Land is assigned at the maximum value of 19,624 acre-feet for Scenario 2, and potential additional seepage losses to L-5 and Miami Canal are neglected. In addition, given the elevated stages along the north and east perimeters of the Holey Land, the historic average annual net seepage loss (taken from Table 10.5 as 36,000 acre-feet per year) are considered to be eliminated. The impact of those changes is the net addition to the Holey Land average annual water balance of roughly 56,000 acre-feet per year. As a result, potential mitigation strategies should be capable of reducing other inflows to the Holey Land by a commensurate amount.

As discussed in Section 9 of this Plan Formulation, seepage upwelling in STA-3/4 was assigned a mean TP concentration of 25 ppb. That same value is applied to seepage upwelling in the Holey Land. Given an incremental inflow due to seepage of 19,624 acre-feet per year at an average TP concentration of 25 ppb, the average annual addition

to the TP load entering the Holey Land is estimated to be 0.6 tonnes. However, that additional load will be more than offset by the reduced inflow loading at G-200A. Mean inflow concentrations at that location can conservatively be expected to reduce from 75 ppb to not more than 50 ppb (the minimum average treatment goal for STA-5 and STA-3/4), resulting in a reduction of 1.7 tonnes per year of TP entering the Holey Land. Given no other changes in Holey Land water management, total TP loads entering the area would be expected to reduce by a minimum of 1.1 tonnes per year. No other mitigation would appear to be necessary in order to prevent an increase in average annual inflow loading of TP in the Holey Land.

10.4.3 Estimated Maximum Annual Impacts due to Project

As discussed in Section 7 of this *Plan Formulation*, construction and operation of STA-3/4 is estimated to result in an additional maximum annual inflow (due to induced seepage) to the Holey Land of between 35,275 acre-feet per year (Scenario 1) and 39,128 acre-feet per year (Scenario 2). That maximum induced seepage would have occurred in 1970. Those values were computed assuming the Holey Land would have existed and been operated in strict accord with the "test" regulation schedule during 1970. Those values do not consider the potential increase in seepage losses to the L-5 and Miami canals due to lowering of stage durations in those water bodies.

In order to assure a degree of conservatism in this analysis, the maximum annual induced seepage to the Holey Land is assigned at the maximum value of 39,128 acre-feet for Scenario 2, and potential additional seepage losses to L-5 and Miami Canal are neglected. In addition, given the elevated stages along the north and east perimeters of the Holey Land, the historic average annual net seepage loss (taken from Table 10.5 as 36,000 acre-feet per year) are considered to be applicable to 1970 as well, and are eliminated. The impact of those changes is the net addition to the Holey Land annual water balance in 1970 of roughly 75,000 acre-feet. As a result, potential mitigation strategies should be capable of reducing other inflows to the Holey Land by a commensurate amount.

As discussed in Section 9 of this Plan Formulation, seepage upwelling in STA-3/4 was assigned a mean TP concentration of 25 ppb. That same value is applied to seepage upwelling in the Holey Land. Given an incremental inflow due to seepage of 39,128 acre-feet at an average TP concentration of 25 ppb, the maximum annual addition to the TP load entering the Holey Land is estimated to be 1.2 tonnes. No information is available on the probable operation of G-200A had the Holey Land Wildlife Management Area existed in 1970. However, given a reduction in inflow concentration at that point from 75 ppb to 50 ppb, G-200A could have been operated at 14% more than its average annual operation without increasing the overall TP load entering the Holey Land. It can therefore be concluded that, even on a maximum annual basis, no additional mitigation would be necessary to prevent an increase in TP loads entering the Holey Land.

10.5 ASSESSMENT OF POTENTIAL MITIGATION STRATEGIES

It is concluded from 10.4 that strategies for mitigation of hydrologic and nutrient loading impacts on the Holey Land due to the construction and operation of STA-3/4 should be capable of either reducing overall inflows or increasing overall outflows by an average of 56,000 acre-feet per year. In addition, those strategies should be capable of either reducing overall inflows or increasing overall outflows by a maximum annual value of 75,000 acre-feet. TP loads entering the Holey Land are expected to reduce from historic levels under both average and maximum annual conditions, and no mitigation is required.

10.5.1 Reducing Inflows

On an average annual basis, it is estimated that the construction and operation of STA-3/4 will result in a net addition to the Holey Land water budget of 56,000 acre-feet per year. As indicated in Table 10.5, the average annual inflow to the Holey Land at G-200A over the period 1996-1999 was 54,000 acre-feet. Comparison of those values suggests that the average annual hydrologic impact on the Holey Land due to STA-3/4 can largely be offset simply through a reduction in the operation of G-200A. That approach would also result in a marked further reduction in the average annual TP load entering the Holey

Land. However, the maximum annual hydrologic impact on the Holey Land could not be offset through a simple reduction in the operation of G-200A.

10.5.2 Increasing Outflows

The maximum annual hydrologic impact on the Holey Land resulting from construction and operation of STA-3/4 is estimated at an increase of 75,000 acre-feet in inflows; that increase would have occurred in 1970 had both the Holey Land and STA-3/4 been in place. No information is available on the probable operation of G-200A in 1970 had the Holey Land existed. It is therefore considered prudent and sufficiently conservative to assume mitigation of those impacts on a maximum annual basis will require development of the capacity to discharge 75,000 acre-feet per year from the Holey Land. During the period 1996-1999, there were virtually no surface-water discharges from the Holey Land.

The discharge of 75,000 acre-feet per year is equivalent to a mean rate of discharge of 104 cfs. Physical means for evacuating water from the Holey Land are limited to gravity discharges or pumped discharges. Those discharges can be directed, dependent upon the physical works in place, to either the L-5 Borrow Canal, the Miami Canal, the G-372 Supply Canal, or the Cell 3 discharge canal in STA-3/4.

In consideration of potential strategies, it is noted that the primary function of seepage return pumping stations G-200B and G-201 will cease to exist upon completion of STA-3/4. With the exception of a short length of the east perimeter of the Toe of the Boot (immediately north of L-5), the seepage collection canal from which these stations draw will no longer exist. It would be practicable to obtain the necessary maximum discharge capacity through reversing the pumps at either G-200B or G-201; reversing the direction of flow at either of those stations would afford a discharge capacity of 165 cfs, roughly 60% more than the mean discharge requirement for the maximum year.

A similar result could be obtained through reversing the direction of flow of one of the three 200 cfs pumps at pumping station G-200A.

Of those three options, it would be considered preferable to reverse the direction of flow at pumping station G-201. Discharges from G-201 would proceed north along the existing seepage collection canal to its confluence with the Cell 3 Discharge Canal immediately west of the rock pits south of the southwest corner of Cell 2B in STA-3/4, and would at that point be combined with STA-3/4 outflows. Holey Land discharges at that point would be considered preferable to discharges at either G-200A or G-200B, as the passage of flow through the Holey Land can be expected to result in improved discharge water quality.

Reversal of one of the pumps at G-200A would in effect reduce the inflow capacity of that station, adversely impacting the District's flexibility for overall water management in the S-8/S-3 (and, to a lesser extent, the C-139) basin.

Should the pumps at G-200B be reversed, discharges at that location could either be directly discharged to the Miami Canal downstream of G-373 (an additional structure may be needed) or released to the inflow canal leading to pumping station G-372. That latter approach would in essence result in the (presently unplanned) inclusion of Holey Land discharge volumes and TP loads in the inflows to STA-3/4.

An evaluation was also made of the potential for effecting gravity discharge from the Holey Land to the L-5 Borrow Canal through existing structures G-204, G-205 and G-206. Figures 10.7 through 10.9 present projected stage-durations in the L-5 Borrow Canal at the locations of those three structures. Those stage-durations are applicable to the period 1965-1995, and were developed specifically for the intentional delivery of maximum discharge volumes from STA-3/4 to pumping station S-8. They also were developed for operating scenario 3 as it is presented in Section 7, and would increase slightly for operating scenario 2. Figures 10.7 through 10.9 also present historic headwater and tailwater stage-durations at each of those three structures. Strict adherence to the "test" operational schedule presented in Figure 10.6 (bottom of blue zone) can be expected to result in a headwater range from 10.75 to 12.0 ft. NGVD at each structure, with a mean stage of 11.3 ft. NGVD.

Here insert Figure 10.7

Here insert Figure 10.8

Here insert Figure 10.9

Inspection of the information presented in Figures 10.7 through 10.9 results in the following conclusions, relative to the entire period 1965-1995:

- It would be possible to discharge by gravity through G-204 whenever the Holey Land stage exceeds the "blue zone" minimum of 10.75 ft. NGVD.
- Tailwater stages at G-205 would remain below 10.75 ft. NGVD roughly 96% of the time, and would remain below the "mean" headwater stage of 11.3 ft. NGVD at all times, permitting discharge by gravity under virtually all conditions.
- Tailwater stages at G-206 would remain below 10.75 ft. NGVD roughly 88% of the time, and would remain below the "mean" headwater stage of 11.3 ft. NGVD roughly 96% of the time, permitting discharge by gravity under most conditions.

The mean total discharge to the L-5 system from STA-3/4 over the period 1965-1995 (operating scenario 3) is shown in Section 9 to be approximately 480,000 acre-feet per year. The maximum discharge to the L-5 canal is estimated to have occurred in 1970, with a maximum volume of approximately 1,098,000 acre-feet (for operating scenario 2). That volume is equivalent to a mean discharge of just over 1,500 cfs. At all three outflow structures, the tailwater stage associated with that mean rate of discharge remains below elevation 10.75 ft. NGVD (given maximum delivery of flow to S-8 and an S-8 headwater stage of 10.0 ft. NGVD). It is therefore concluded that substantial capacity for gravity discharge could have been expected in 1970 as well, and should readily exceed the desired mean discharge capacity of 104 cfs.

10.6 RECOMMENDATIONS

As discussed above, the hydrologic impacts of the construction and operation of STA-3/4 and the East WCA-3A Hydropattern Restoration on the Holey Land can be offset by:

- Reversing the direction of discharge at either pumping station G-200B or pumping station G-201, or reversing the direction of discharge of one pump at G-200A. Of those three options, reversing the direction of discharge at G-201 would be preferred.

- Operating structures G-204, G-205 and G-206 as necessary to permit maintenance of the desired schedule in the Holey Land. This option is considered preferable to reversing the direction of flow at G-201, due to lowered first cost and reduced costs for operation and maintenance.

Either of the above options is capable of addressing the additional water load on the Holey Land occasioned by STA-3/4. An additional step which can be taken (and would approach the capacity in an average year to offset impacts in and of itself) would be to simply reduce inflow pumping at G-200A, as induced seepage due to STA-3/4 is estimated to be adequate to replace that normal inflow volume.

Final recommendations are formulated recognizing that, upon completion of Phase 2 of the Everglades Construction Project and compliance with final phosphorus criteria in discharges from STA-3/4, it may be practicable to further modify the project to establish sheet flow discharge to WCA-3A. Should that modification be implemented, stages in the L-5 Borrow Canal would increase, with the result that primary reliance on gravity outflow might no longer be possible. It is therefore considered desirable to retain pumping station G-201 in place to provide maximum flexibility for Phase 2.

It is recommended that:

1. The operation of pumping station G-200A be limited to the minimum necessary to address other water management needs in the S-8/S-3 basin, and not be initiated solely for the purpose of increasing Holey Land stages.
2. Pumping station G-201 be taken out of service, but left in place for future operational flexibility.
3. Structures G-204, G-205 and G-206 be used to effect necessary discharges from the Holey Land.
4. Pumping station G-200B be removed from service.